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THESIS

IMPLEMENTATION OF "MARGINALISM" IN DAY TO DAY LIFE

by

Elyezer Shkedy

June 1998

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IMPLEMENTATION OF "MARGINALISM" IN DAY TO DAY LIFE

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requirements for the degree of

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ABSTRACT

Economics, and especially the theory of Marginalism, can be very useful in "day-to-day" life, but for many reasons people do not really use it. This work tries to explain the "economic way of thinking" basically by verbally explaining the main idea, by providing examples from day-to-day life with minimum needed mathematics, and exploring the most important steps in the decision-making process. Hopefully, this work will encourage people to adopt and use the economic way of thinking and, as a result, gain its benefits.

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I. INTRODUCTION

A. GENERAL

"You can look at everything in the world as an economic issue." These were the words of Professor Terasawa while discussing a topic which seems quite far from the area of microeconomics, the process of establishing a new squadron. Prof. Terasawa's statement seemed strange at the time, but after some thought, I reached the conclusion that it is true. Almost every subject, from the simple to the most complicated, can be analyzed using microeconomics tools and according to the marginalism concept. From my experience, I realized that I managed some of the most complicated processes with a very successful outcome according to my way of thinking (without knowing how to define it and what to call it). I had some difficulties with the applicability of this theory to emotional and irrational matters, but that is another issue.

B. INTEREST

During the Microeconomics and the Policy-Analysis courses, I faced two interesting questions: 'how to allocate the cake to achieve efficiency" and "how to increase the cake by allocation and incentives." I liked the concept of marginalism as the solution to the allocation question, and I found it very useful. One thing that surprised me was that intelligent and educated people tend not to use it. Even students who just finished studying the subject (or while studying the subject) face difficulties implementing the ideas in the real world. After some investigation, I observed a variety of investments of resources in the university, in my home and in other places dealing with major issues that would have probably been invested in different ways with the proper knowledge.

C. INABILITY TO USE "THE ECONOMIC WAY OF THINKING"

While reading economics books I realized that I share the feeling about misunderstanding and fear of economics with important writers. Rhoads wrote about misunderstanding and about thoughts of unrealistic assumptions:

> Economists feel misunderstood. People notice only their showy, disheveled, and presumptuous half, macroeconomics, while their solid, elegant, better half, microeconomics, remains unseen. [Ref. 3:p. 1]. Noneconomists who know a little about microeconomics analysis often think economics is mainly theory built on unrealistic assumption. [Ref. 3:p. 8]

Maurice and Smithson wrote about the difficulties in implementation and about thoughts of the real world:

> All too often, students leave economics courses with the mistaken view that economics is somehow akin to metaphysics. Many of our students have been very surprised to find that the solutions we illustrate graphically can be implemented using real-world data to provide the profit-maximizing solution. [Ref. 7:p. IX]. No doubt you have heard statements as: 'That's OK in theory, but how about the real world?' [Ref. 7:p. 5]

D. PURPOSE

The main purpose of this thesis is to help people better understand the marginalism concept, lead them to see its advantages and encourage them to use it by showing that it can be done with minimal usage of math. This thesis explains in simple words the meaning of the "economic way of thinking" or "marginalism," gives examples of implementation in "day-to-day life" and emphasizes the basic and most important steps needed to use it. People tend to act logically according to their background and the knowledge they have. Here I try to spread useful economics knowledge. This exploration, hopefully, will lead people to adopt the economic way of thinking for almost any situation and, thereby, gain many benefits.

> Rhoads wrote that the concept of marginalism does not seek to provide comprehensive frameworks or conclusive answers; it is, instead, ideas to be kept in mind-factors to be weighted against other relevant factors when thinking through a problem or policy. [Ref. 3:p. 4]

E. ORGANIZATION OF THE THESIS

The thesis is organized into five chapters. Chapter I is an introduction to the thesis. Chapter II provides the theoretical background to the idea with a minimum of mathematics and a separate part which includes the mathematics for those interested. Chapter III gives examples from different fields that show the "regular behavior" and the "marginal behavior," the differences between them, and explains how to create the right allocation of the most limited resource, time. Chapter IV explores the development and the explanation of the basic process and the implementation of the general idea. Chapter V provides the conclusions.

II. BACKGROUND

A. INTRODUCTION

> Economic analysis is basically marginal analysis. Many economists even use the word marginalism to refer to what we have called 'the economic way of thinking.' Marginal means on or at the edge. A marginal benefit or a marginal cost is the additional benefit or cost. Economic theory is marginal analysis because it assume that people make decisions by weighing additional benefits against additional costs, all measured from the spot on which the decision-maker currently stands. [Ref. 1:p. 105]

If we have limited resources like time, money, etc., the big question is how to allocate these resources in order to achieve maximum benefits. Marginal analysis suggests that it is the weight of the additional benefits against the additional investment, not the total, average, or cost. Professor Terasawa expressed it as: "The marginal concept says that we will do it right if the marginal benefit of the last unit of limited (constrained) resource used will be the same for every usage."[1]

Practically, we should invest (increase the value) in the factor that will give us the maximum benefits until we reach the point that investment in this factor will give less benefits than investment in another factor. At this point we should switch the investment to the other factor. For example, since we have only a limited number of hours to spend, our time is a limited resource. The marginal productivity of time relates to how many benefits (such as money, points, etc.) we get from the last unit of time we spend.

1. Efficiency

Efficiency and economics emphasize effectiveness:

> Efficiency is the virtue most consistently praised by economists. That should occasion no surprise, since efficiency and economy are

[1] The equality of the marginal benefits among all variables presupposes the interior solution.

> practically synonymous. Both terms refer to the effectiveness with which means are used to achieve ends. Getting as much as possible out of the scarce resources available - this is what is meant by efficiency and by economy. [Ref. 1:p. 133]

2. Choice of the Individual

The answer to the basic question of how individuals choose is by trying to maximize their benefits: "The fundamental assumption of the economic way of thinking is that all social phenomena emerge from the choices individuals make in response to their expected benefits and costs." [Ref. 1:p. 14]. "People seek either to maximize the benefits they receive or minimize the costs from the other activities they undertake." [Ref. 7:p. 43].

People act logically in order to maximize their benefits. People are different, so the benefits they wish to achieve vary according to each situation and to their background, culture, wealth, personality etc. People make their decisions in order to gain the maximum benefits according the knowledge they already have. It is possible that improving their knowledge about maximization can allow them to act in different and more efficient ways.

3. Average/Marginal

There is a big difference between the two concepts. The main idea of marginalism is to switch the focus from average to marginal: "The economic way of thinking rejects the all-or-nothing approach in favor of attention to marginal benefits and marginal costs." [Ref. 1:p. 106].

> Whether or not business people cast their thinking in terms of average, it is expected marginal costs that guide their decisions. Average can be looked at after the fact to see how well or poorly things went, and maybe even to learn something about the future if the future can be expected to resemble the past. But this is history again-admittedly an instructive study-whereas economic decisions are always made in the present with an eye to the future. [Ref. 1:p. 111].

> The main point about the marginalist theory is that it switches the focus of attention from the average or normal price, value or cost to the price, value or cost of the marginal item, that is the item just inside or just beyond the edge of what is actually produced or sold. [Ref. 8:p. 2]

4. Marginalism

> What exactly do we mean by the economic way of thinking? To begin with, it is exactly what the term suggests: an approach, rather than a set of conclusions. John Maynard Keynes phrased it aptly in the statement quoted in the front of this book: 'The theory of Economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking which helps its possessor to draw correct conclusions.' [Ref. 1:p. 4]

Rhoads and Heyne wrote about "Adam Smith's Paradox;" about misunderstanding the concept of marginalism even by a very famous economist:

> Adam Smith struggles with what came to be called the paradox of value in use versus value in exchange. Water is necessary to existence and of enormous value in use. Diamonds are frivolous and clearly not essential. The price, however, of diamonds, their value in exchange, is far higher than that of water.... Smith had failed to distinguish between total and marginal utility. [Ref. 3:p. 25]

> To make the choice, we ask ourselves not whether diamonds or water gives more satisfaction in total, but whether more of one gives greater additional satisfaction than more of the other. For this marginal utility question our answer will depend on how much of each we already have. [Ref. 3:p. 25]

"Transfer these same people to the desert and let them go without water for a week, and the relative prices they would pay for water and diamonds would change dramatically." [Ref. 1:p. 106].

From what Rhoads wrote about Maslow we can reach the conclusion, even though not written, that Maslow accepted the idea of marginal utility:

> A. H. Maslow was a psychologist whose work on human motivation has been influential in fields such as organization development and

> industrial psychology. Maslow argued that basic human needs can be catalogued and ranked according to their importance in providing motivation and influencing behavior. He saw physiological needs such as water, food, sex, and sleep as the most fundamental, demanding, and powerful. However, if the physiological needs 'are relatively well gratified, there then emerges a new set of needs' pertaining to safety. Once the safety needs of security, order, and protection are 'fairly well gratified' there then 'emerge' love, affection, and belongingness needs. When these have been satisfied, needs for esteem (achievement, reputation, prestige) take over, and these, when satisfied, are replaced by the need for self-actualization, 'the desire to become more and more what one is, to become everything that one is capable of becoming.' Maslow did not hold rigidly to this ordering of needs. He said there will be exceptions and that a need does not have to be satisfied 100 percent before the next need emerges. [Ref. 3:p. 27]

Rhoads emphasizes the idea of proportion as another expression of marginalism: "Marginalism suggests that our real concern should be with proportion." [Ref. 3:p. 31] He also states: "reasonable policy choices require knowledge of how well we are now doing in all of these areas and of the alternative opportunities available." [Ref. 3:p. 32] "Marginalism thus requires looking at the details regarding the costs and benefits of particular opportunities" [Ref. 3:p. 32]. Maurice and Smithson summarized marginalism as the key factor in optimization: "marginal changes are the key factor in optimization decisions." [Ref. 7:p. 60]

5. Three Ways of Expression

Marginalism can help us to find the way to decide where to invest in order to get the maximum benefit. Reaching the right allocation can be done in three ways:

- Mathematically, by using algebra (Lagrangian function)
- Graphically, by doing indifference curve analysis.
- Verbally, by thinking and explaining the marginal concept.

In this work I will try to use the verbal way with the minimum mathematics required for practical use.

B. MARGINALISM IN "MATHEMATICAL WORDS"

1. Mathematical Meaning

I am going to show what is the mathematical meaning of objective function maximization by expressing the principles of "constrained optimization" in mathematical language. [based on Professor Terasawa and Maurice & Smithson (Chapter 3).]

Consider an objective function with n variables:

$$\theta=\theta(X1,X2,X3,....,Xn)$$

The marginal benefit from Xi is the partial derivative of the objective function, $\partial\theta/\partial Xi$.

Consider a constraint function:

$$\phi=\phi(X1,X2,.....,Xn)=0$$

The marginal cost of Xi is the partial derivative, $\partial\phi/\partial Xi$.

To reach an optimum (maximize or minimize the objective function), we can use the Lagrangian function:

$$L=\theta(X1,X2,....,Xn)-\lambda(\phi(X1,X2,....Xn))$$

All the partial derivatives should be equal zero:

$$(\partial L/\partial X1)=(\partial\theta/\partial X1)-\lambda*(\partial\phi/\partial X1)=0$$

$$(\partial L/\partial X2)=(\partial\theta/\partial X2)-\lambda*(\partial\phi/\partial X2)=0$$

$$(\partial L/\partial X3)=(\partial\theta/\partial X3)-\lambda*(\partial\phi/\partial X3)=0$$

$$(\partial L/\partial X4)=(\partial\theta/\partial X4)-\lambda*(\partial\phi/\partial X4)=0$$

$$(\partial L/\partial Xn)=(\partial\theta/\partial Xn)-\lambda*(\partial\phi/\partial Xn)=0$$

The condition for an optimum (minimum or maximum of the objective function) when all the variables are satisfied is:

$$(\partial\theta/\partial X1)/(\partial\phi/\partial X1)= (\partial\theta/\partial X2)/(\partial\phi/\partial X2)= (\partial\theta/\partial X3)/(\partial\phi/\partial X3)= (\partial\theta/\partial Xn)/(\partial\phi/\partial Xn)= \lambda$$

and $\phi(X1, X2 , X3,...Xn) = 0$

We reach the optimum feasible solution when the ratio of the marginal benefits and marginal costs are equal for all of the variables.

2. "Translation of the Mathematics"

Let us look at a generic problem:

Objective-Function	a combination of variables that describe the objective.
Variables	factors that influence the solution.
Constraints	there are some limitations on these variables.

The mission is to find the values of the variables that will maximize or minimize the objective function, yet satisfy the constraints.

This means:

Objective function = Goal.

Variables = Factors that can affect the goal
(where the resources should be invested).

Constraints = Constraints

3. The Principle

Maurice and Smithson expressed the principle of constrained optimization as follows: "An objective function is maximized or minimized subject to a constraint if, for all of the variables in the objective function, the ratio of marginal benefit to marginal cost are equal." [Ref. 7:p. 55]

III. EXAMPLES

A. INTRODUCTION

In this chapter, I will present two examples from "day to day" life. Each example will be described as follows:

1. Background.
2. The common behavior (or expected behavior).
3. The proposed behavior (according to the marginalism concept).
4. Discussion.
5. The practical behavior.
6. Common problems.
7. Mathematical point of view (for those interested)

B. GENERAL DEFINITIONS

Terms and meaning to be used throughout the text:

- Goal- the main objective.
- Constraints- the limitations or conditions that must be filled.
- Factor- a relevant factor that can affect achieving the goal.
- Weight- the value of each factor in terms of the goal, like points, money, etc.
- Percent- the total part of the weight that can be gained or saved.
- Unit- the length of a time.
- Improvement- the ability to improve the factor using one unit of time.

C. EXAMPLE #1: FAMILY BUDGET

1. Background

Let's say that a family includes a husband, wife, and three children. Both parents work six days a week. During the last few weeks they were discussing some issues:

- Stop renting a house and buy one instead.
- Buy new clothes for each of them (they speak about outlets and sales).
- Lower household expenses by using the coupon system at the grocery store.
- Take a vacation.

2. Common Behavior (or Expected Behavior)

They act logically according to their best knowledge trying to do the best in each area. They decide to take the next practical steps:

- Contact a Real Estate agency in order to find a house and obtain a home loan.
- Drive to the closest outlet stores (Gilroy…) to buy clothes, and look more seriously for good sales in the area.
- Use the coupon system in Lucky for the next monthly grocery buying.
- Visit a travel agency to make a reservation for their coming vacation next month.

3. Proposed Behavior

a. Goal & Constraints

Define the goal and the constraints. What is the goal while spending time managing a house, and how many hours do we have to spend during this month. In this example I will set the goal and the constraints as follow:

Goal: maximum saving or gaining of money.

Constraints: The family wants to achieve a certain level of happiness by dealing with, at the least, buying a house, clothes, grocery items, and taking a vacation next month. They have only 60 hours this month to spend on these issues.

b. Factors

Determine the factors. Search for factors which might be relevant in reaching the goal. What are all the factors that will affect the goal of maximum saving of dollars. Here the factors are not only the areas that were discussed by the family members, but can be expanded to other areas such as the car, bank loans, children's activities and the cost of each, the salary needed, etc. For simplicity in this case, I will add only one more factor to the factors already discussed by the family - the wife's job. The mother is considering changing her job and is looking for a promotion and higher salary. Thus, the five factors are as follows:

Factors:

- House
- Clothes
- Groceries (Lucky)
- Vacation
- Job

c. Weight (in $)

Determine the influence of each factor by estimating its monetary worth. Each factor involves a different amount of money. For example, the house they intend to buy is valued at about $300,000, but the clothing allotment is approximately $500.

1. House $ 300,000
2. Clothes $ 500
3. Lucky buying $ 300
4. Vacation $ 3,000
5. Job $ 2,500

The total amount of money relevant for the current month is $306,300.

d. Percent

If you have all the time in the world, then you will be able to save money in each factor (each area). If you are looking for a house that is worth $300,000, with some work you may be able to find a good deal that will save you around 5%, but you can assume that you will not be able to save 40% of the value of a house. However, when you are looking for clothes, you can assume that you will be able to find good sales that can save you 25% of the expected prices.

This is an estimation of what can be saved or gained by investing all the time needed in this area in terms of percent of the total money for each factor. (The percentage can be calculated after estimating the maximal gain or saving in dollars per each factor divided by the weight of each factor).

1. House 5% = 0.05
2. Clothes 25%=0.25
3. Lucky 30% =0.30
4. Vacation 20%=0.20
5. Job 10%=0.10

e. Unit

Determine the "unit-of-time" block. We know from our constraints that we have only 60 hours to spend this month on these subjects. This time is likely to be spent going to property agencies searching for a house, visiting travel

agencies looking for vacations, or driving to the nearest outlet, each of which will take you at least 6 hours. In this example, I will count 6 hours as one unit of time and make this unit the minimal effective amount of time needed for getting some improvements in our current situation. If we assume that you want to invest the least number of hours in one factor, the minimal number of hours will be called a unit. In this example, one unit is 6 hours. We know that we have only 60 hours to spend this month, so we have 10 units of time to spend (60/6).

Unit: 6 hours

Number of units: 10 units (of 6 hours each)

f. Improvement

By spending one unit of time (6 hours) on a subject, we will probably not achieve the whole savings we can obtain if we invest much more time in that subject. For example, if we look for good sales and search the stores for 100 hours, we can assume that we will find better opportunities for saving than by searching for 6 hours. We have to decide what will be our ability to improve in each factor (area) if we spend one unit of time (the next 6 hours) on it. In this example, I estimated that by investing the first 6 hours in searching for a house I can capture 10% of the potential saving. Here is how an investment of the first "unit" of time in a factor will improve your saving in that area:

1. House 10%=0.1
2. Clothes 30%=0.3
3. Lucky 30%=0.3
4. Vacation 25%=0.25
5. Job 20%=0.2

g. Calculations

Now we have to calculate two things: First, what is the real weight of each factor, the maximum saving we can get from each factor; and, second, what is the real value of our time and how much benefit (dollars) can we get by spending one unit of time on each factor.

h. Real Weight

If the value of a house is $300,000 and we estimate that spending all the time needed in this area will save 5%, the real weight of the house (or the maximum saving) is 300,000*0.05=15,000. The real weight is the maximum benefits from investing all the time needed in each factor. For each factor:

REAL-WEIGHT = WEIGHT * PERCENT.

1. House 300,000*0.05=15,000
2. Clothes 500*0.25=125
3. Lucky 300*0.30=90
4. Vacation 3,000*0.2=600
5. Job 2,500*0.1=250

i. Real-Value of Time

If the maximum saving we can get on searching for a house is $15,000 and the expected improvement of our ability to save by spending one unit of time (6 hours) is 10%, then by spending this unit of time on a house we can save 15,000*0.1=1500 dollars. This $1500 is the expected benefit from investing the next 6 hours in a house. The real value of time is the benefits gained from investing one unit in each factor in dollars. For each factor:

REAL-VALUE OF TIME = REAL-WEIGHT * IMPROVEMENT

1. House 15,000*0.1=1500
2. Clothes 125*0.3=37.5

3. Lucky 90*0.3=27

4. Vacation 600*0.25=150

5. Job 250*0.2=50

j. Table

To better illustrate the process it is helpful to create a table. Arrange all the details in a table that summarize all the above. An example of such a table is given here (Table 1).

Table 1. Investment of the First Unit of Time for Saving

EXAMPLE TABLE (NUMBERS FROM EXAMPLE # 1 IN $)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	0.1	**$1,500**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	
TOTAL	$306,300		$16,065			

The meaning :

The total amount of dollars they are going to spend is $306,300.
The total amount of dollars that can be saved is $16,065.

Investing the first unit of time (6 hours) in searching for a house will save $1,500.
Investing the first unit of time (6 hours) in buying clothes will save $37.5.
Investing the first unit of time (6 hours) in lucky will save $27.
Investing the first unit of time (6 hours) in searching for vacation will save $150.
Investing the first unit of time (6 hours) in searching for a job will save $50.

The best choice is to invest the first unit of time (6 hours) in searching for a house. It will save $1,500.

k. Decisions

(1) **Decision Process.** We can see the following from the table: by spending the first 6 hours (first unit of time) on searching for a house, we can save $1500; by spending the first 6 hours (first unit of time) on clothes, we can

save $37.50; by spending the first 6 hours (first unit of time) on the Lucky coupons, we can save $27; by spending the first 6 hours (first unit of time) on searching for a good vacation deal, we can save $150; and by spending the first 6 hours (first unit of time) on the wife's job, we can save $50. It is obvious that the best way to spend the first 6 hours (first unit of time) is on searching for a house. The first unit of time should be spent in the factor with the highest "real value of time," that is the highest expected benefits in dollars.

(2) **Continue the Process.** After spending the first 6 hours of time on searching for a house, we should decide where to spend the next 6 hours (the next unit of time). Now we have to estimate our ability to reduce the cost of a house if we spend the next 6 hours in this area, but our improvement will probably be, at most, equal to or less than our improvement in the first 6 hours. If in the first 6 hours we improved 10%; again, we will likely only improve by the same or a smaller amount now. In this example, I assume that the amount of saving captured by spending the next 6 hours will be 5%. It is important to understand that nothing changed in the other factors (other areas); and the only thing that changes is the ability to improve by searching for a house, in other words, the real value of time in house hunting - the benefits we expected to get by spending the next unit of time in searching for a house. The example of spending the next unit of time (the next 6 hours) is given here (Table 2):

Table 2. Investment of the Next Unit of Time for Saving

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.05**	**$750**	*
CLOTHES	$ 500	0.25	$ 125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$ 600	0.25	$ 150	
JOB	$2,500	0.1	$ 250	0.2	$ 50	

The only thing that has to be changed is the ability to improve dealing with a house from 10% to 5% (from 0.1 to 0.05)

The highest benefit by spending the next unit of time (6 hours) is in searching for a house - saving $750

We can see the following from Table 2: spending the next 6 hours (the next unit of time) in searching for a house will save us $750; spending the next 6 hours (the next unit of time) searching for clothing bargains will save us $37.50; spending the next 6 hours (the next unit of time) in Lucky coupons will save us $27; spending the next 6 hours (the next unit of time) in searching for a vacation deal will save us $150; and spending the next 6 hours (the next unit of time) searching for a job will save us $50. We can see that the best place to spend our next 6 hours should again be on searching for a house, it will give us the highest benefits ($750).

This process should be repeated again after using each unit of time in order to decide where to invest the next unit. After spending time in an area, the ability to improve in that area has changed and is now equal or smaller than before. This reduces the benefits expected from this factor. Therefore, every 6 hours (one-unit), stop, estimate and change the "improve" to the new value. Find the factor with the new highest "real value" and invest there.

(3) **Optional Alternative Schedule.** This process can, and likely should, be done in advance. In order to arrange an accurate schedule of managing the house, these calculations can be made in advance. If you choose to calculate in advance, you have to estimate all the changes in "improvement" at the beginning of the process and not after each unit of time and then calculate the benefits in the same way. This will give you a full picture about how many units of time need to be spent in each area, the order will be flexible but in exactly the same proportion, as a sequential process.

(4) **Process Tables.** Example of investing 10 units of time (60 hours which are 10 units of 6 hours) is given here (Table 3.1 - 3.10)

Tables 3. 1 - 3.10. Investment of Ten Units of Time for Saving (Ten Units of Six Hours Each)

Table 3.1

STEP 1 investing the first unit of time (6 hours)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	0.1	**$1,500**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit by spending the next unit of time (6 hours) is in searching for a house is - saving $1500

INVEST IN HOUSE

Table 3.2

STEP 2 investing the second unit of time (6 hours)

The only thing to be changed is the ability to improve dealing with a house (from 0.1 to 0.05)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.05**	**$750**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house - saving $750

INVEST IN HOUSE

Table 3.3

STEP 3 investing the third unit of time (6 hours)
The only thing to be changed is the ability to improve dealing with a house (from 0.05 to 0.03)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.03**	**$450**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house - saving $450

INVEST IN HOUSE

Table 3.4

STEP 4 investing the fourth unit of time (6 hours)
The only thing to be changed is the ability to improve dealing with a house (from 0.03 to 0.02)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.02**	**$300**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house - saving $300

INVEST IN HOUSE

Table 3.5

STEP 5 investing the fifth unit of time (6 hours)

The only thing to be changed is the ability to improve dealing with a house (from 0.02 to 0.015)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.015**	**$225**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house - saving $225

INVEST IN HOUSE

Table 3.6

STEP 6 investing the sixth unit of time (6 hours)

The only thing to be changed is the ability to improve dealing with a house (from 0.015 to 0.01)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.01**	**$150**	*
CLOTHES	$500	0.25	$125	0.3	$37.5	
LUCKY	$300	0.3	$ 90	0.3	$ 27	
VACATION	3000	0.2	$600	0.25	**$150**	*
JOB	2500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house or in looking for a good vacation deal - the benefit is $150

Either invest in house or vacation. In this example I choose to continue investing in searching for a house

INVEST IN HOUSE

Table 3.7

STEP 7 investing the seventh unit of time (6 hours)

The only thing to be changed is the ability to improve dealing with a house (from 0.01 to 0.0075)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	**0.0075**	$112.5	
CLOTHES	$ 500	0.25	$125	0.3	$ 37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	**$150**	*
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) in searching for a vacation deal - saving $150

INVEST IN VACATION

Table 3.8

STEP 8 investing the eighth unit of time (6 hours)

The only thing to be changed is the ability to improve dealing with a vacation (from 0.25 to 0.15)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	0.0075	**$112.5**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	**0.15**	$ 90	
JOB	$2,500	0.1	$250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house is - saving $112.5

INVEST IN HOUSE

Tables 3.1 -3.10 (Continued)

Table 3.9

STEP 9 investing the ninth unit of time (6 hours)
The only thing to be changed is the ability to improve dealing with a house (from 0.0075 to 0.005)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	15000	**0.005**	$ 75	
CLOTHES	$ 500	0.25	125	0.3	$37.5	
LUCKY	$ 300	0.3	90	0.3	$ 27	
VACATION	$3,000	0.2	600	0.15	**$90**	*
JOB	$2,500	0.1	250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a vacation deal - saving $90

INVEST IN VACATION

Table 3.10

STEP 10 investing the tenth unit of time (6 hours)
The only thing to be changed is the ability to improve dealing with a vacation (from 0.15 to 0.1)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	15000	0.005	**$ 75**	*
CLOTHES	$ 500	0.25	125	0.3	$37.5	
LUCKY	$ 300	0.3	90	0.3	$ 27	
VACATION	$3,000	0.2	600	**0.1**	$ 60	
JOB	$2,500	0.1	250	0.2	$ 50	

The highest benefit is by spending the next unit of time (6 hours) searching for a house - saving $75

INVEST IN HOUSE

We can see that we invest in the most valuable factor each time. The saving from the first unit of time (6 hours) is $1500, and the saving from the tenth unit of time (6 hours) unit is $75. We did not invest time in clothes, Lucky or job at all. Doing it in this order, stopping at any time we invested the time in the best way possible. In areas I decided not to deal with, I will not invest time at all. Or, if I must deal with this factor, I will simply invest the minimum amount of time.

(5) **Comments**

- It is recommended to use this process especially:
  - When you have no "smart people" or good advisers in the area to learn from....
  - When the weight of a factor changes.
  - When another factor is added or deleted

(6) **Changing Situations Tables**. For illustration, Table 4 shows:

- Weight change, such as changing the amount of money we intend to spend on a house.
- Changing our estimate about the percentage that can be saved on a house.
- Added factors, such as buying a car.

Table 4. Changing Situations

Changing Weight from a $300000 House to a $200000 House

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	**$200,000**	0.05	$10,000	0.1	**$1,000**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

We will get the highest benefits by spending the first unit of time (6 hours) in searching for a house $1000

INVEST YOUR FIRST UNIT OF TIME IN SEARCHING FOR A HOUSE

Table 4 (Continued)

Changing The Percentage of Estimated House Savings to 3%

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	**0.03**	$9,000	0.1	**$900**	*
CLOTHES	$ 500	0.25	$125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$3,000	0.2	$600	0.25	$ 150	
JOB	$2,500	0.1	$250	0.2	$ 50	

We will get the highest benefits by spending the first unit of time (6 hours) in searching for a house $900

INVEST YOUR FIRST UNIT OF TIME IN SEARCHING FOR A HOUSE

Adding One More Factor (Buying A Car)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
HOUSE	$300,000	0.05	$15,000	0.1	**$1,500**	*
CLOTHES	$ 500	0.25	$ 125	0.3	$37.5	
LUCKY	$ 300	0.3	$ 90	0.3	$ 27	
VACATION	$ 3,000	0.2	$ 600	0.25	$ 150	
JOB	$ 2,500	0.1	$ 250	0.2	$ 50	
CAR	**$30,000**	**0.1**	**$3,000**	**0.25**	**$ 750**	

We will get the highest benefits by spending the first unit of time (6 hours) in searching for a house $1500

INVEST THE FIRST UNIT OF TIME IN SEARCHING FOR A HOUSE

4. Discussion

People are different. They have different backgrounds in wealth, culture, personality, flexibility, need for harmony, and values. The diverse characters of people may lead them to different goals (different objective functions). For example, the goal of very rich people is often quite different from that of less affluent people when dealing with certain issues. Very rich people may place a different emphasis on money, satisfaction, joy and happiness.

Goals are not always defined as clear cut. Sometimes the goal is a combination of some measurable elements (like money) with some immeasurable elements (like happiness). For example, the value of taking a ride to shopping outlets in Gilroy may be measured not only in the relevant available saving but in the enjoyment that this ride provides for all the family. They anticipate the event a week in advance, so there are benefits other than money that were not taken into the account in the measurable proposed concept.

This argument is very important and cannot be ignored. The advantage of this concept is that you can better understand how much the enjoyment of the trip to Gilroy will really cost you (the difference between the saving from the best analyzed activity and the saving from the shopping activity in Gilroy for the next unit of time). With this knowledge, perhaps you will decide to arrange your time and activities in different ways; to choose one activity in order to save money and a different activity for enjoyment. For example, you can think about an activity that is very enjoyable but is also quite expensive, such as taking your children to a 49ers game or taking your wife to a concert in San Jose. You will be able to afford these activities by not taking the ride to Gilroy and, instead, searching for a house. By doing the more beneficial actions, you can enjoy much more and still save much more. This result will occur because you invested the very limited number of hours that you have in a productive way.

The tendency of people to act according to logical thinking can probably lead them to make better decisions when they have more knowledge and a better ability to analyze, and will allow them to make the needed adjustments for immeasurable factors.

5. Practical Behavior

- Define the goal (the highest gain/saving money).
- Understand the real weight; the maximum saving you can get from each factor (usually the first unit should be invested in this factor).
- Estimate what is your knowledge in each factor and your ability to improve in each area.
- Use your intuition to choose the most valuable area where you gain the maximum money per investing a unit of time (beginning direction).
- After a period of time, stop and think again about the new situation. (before deciding on investing the next time unit)
- **You must constantly think in terms of how much money you will gain from investing a unit of time in each factor and choose the most valuable factor that will lead you to gain the most.**

6. Common Problems

When making decisions, many people have an unclear definition of the real goal. The goal must be defined first, then all the factors can be created. Only this process allows you to see the whole picture. Other problems include:

- Lack of determination - what are the relevant factors in order to achieve the goal.
- Lack of knowledge about the real value of each factor and the relative situation among the factor's values.
- Tendency to invest time in familiar areas/factors (like shopping) instead of in the most valuable factor. There is an uncomfortable feeling in unfamiliar areas (like banks, loans, investments, dealers, and real estate agencies), and a much more comfortable feeling in familiar areas like shopping.
- Cutting in the visible places, while wasting or not saving in the more important places. Because one doesn't see the whole picture, and does not define the goal or find all the relevant factors, they end up dealing only with the "visible factors."
- Being attracted to factors by commercials or advertisements rather than by analyzing the real value.

- Lack of knowledge about when is the right time to "switch" investments.
- Even when taking the right approach, it is difficult to know when to switch factors (that is, when to invest time in another factor instead of in the current factor).
- Thinking mainly in a chronological way.
- Difficulties in taking the "right approach" (where to invest the first unit).
- Using intuition without the necessary knowledge can lead people to make wrong decisions about the direction and when to switch.
- Inside the area/factor, people succeed in maximizing their profit (they will find the best sale, but it may be not the right place to invest time....)
- Most of the people try to find their solution "inside the box," and there is a lack of creative solutions outside the box. For example, in this case, thinking outside the box can be creating another different factor that can affect the same goal or try to change the constraints by thinking about another idea, such as not working and taking a break to look for a house, creating more time to spend on that task, possibly losing money in the short term, but saving more money in the long term.
- Only a few people look at their time as an important resource that must be invested wisely (at least only few people behave that way...).
- Lack of good examples of the "right behavior" can cause difficulties.

When the weight of a factor changes, or when a new factor is added to the list, behavior is adjusted slowly.

7. Mathematical Analysis

The following mathematical analysis is based on the background of this thesis.

a. Objective Function

The mission (goal) is to maximize an objective function in order to get the maximum benefits (here, saving dollars). The objective function is a function of the time allocated to factors 1 through n (if we have n areas),

$$\theta=\theta(T1, T2, T3\ldots Tn)$$

b. Constraint

There is a limited amount of time available for searching for savings:

$$T1+T2+T3+\ldots. +Tn = T$$

The constraint function is

$$\phi=T1+T2+T3+\ldots+Tn-T=0$$

c. The Lagrangian Function

The Lagrangian function is:

$$L=\theta(T1, T2, T3, Tn)-\lambda(T1+T2+T3+\ldots+Tn-T)$$

d. Maximization

For maximization, the partial derivatives of this function must be equal to zero, meaning.

$$\partial L/\partial Ti=\partial\theta/\partial Ti-\lambda*1=0 \qquad \text{for every I = 1, 2,...n}$$

The objective function is maximized when:

$$\partial\theta/\partial T1=\partial\theta/\partial T2=\partial\theta/\partial T3=\ldots=\partial\theta/\partial Tn=\lambda$$

and

$$T1 + T2 + T3 +...Tn = T$$

and

$$\theta(T1, T2, T3,...Tn) \text{ is strictly quasi-concave}$$

A maximum saving is achieved when time is spent so that the marginal benefit from additional time allocated to a factor is the same for all the factors. In this example, the marginal benefit of spending an additional one unit of time (6 hours) to search for a specific factor is the dollars saved or gained from that factor.

D. EXAMPLE #2: STUDENT ACADEMIC ACHIEVEMENTS

1. Background

Let's say that a student takes five courses:

Mathematics - 6 hours per week with credit of 6 academic points.

Economics - 5 hours per week with credit of 5 academic points.

Accounting - 4 hours per week with credit of 4 academic points.

Communication - 3 hours per week with credit of 3 academic points.

Geography - 1 hour per week with credit of 1 academic point.

The total grade in mathematics will be constructed from 2 exams. Each exam will be 50% of the grade. The total grade in economics will be constructed from 2 exams. Each exam will be 50% of the grade. The total grade in accounting will be constructed from 2 exams. Each exam will be 50% of the grade. The total grade in communication will be constructed from 4 exams. Each exam will be 25% of the grade. The total grade in geography will be constructed of class participation 25% , a final paper 70% , and one test 5% .

A student has to take three tests during the following week (day after day). Test 1 is on Tuesday with a value of 5% of the total grade in geography. Test 2 is on Wednesday with a value of 25% of the total grade in communication. Test 3 is on Thursday with a value of 50% of the total grade in mathematics.

2. Common Behavior (or Expected Behavior)

Studying is done according to chronological order: for the first test, then for the second test and then for the third test. Studying is usually based on intuition, with a little more effort on some subjects.

3. Proposed Behavior

a. Goal & Constraints

Defining the goal and the constraints. What is the goal while studying in a university, and what are the limitations of time we have on the studying. There is a big difference in strategy if the goal is obtaining the highest possible grade in a specific course without considering the importance of the other grades, as opposed to achieving the highest average grade over all courses during that quarter.

Goal: Assume that the goal is achieving the highest academic average grade.

Constraints: Assume we have only 20 hours to study this week.

b. Factors

Determine the factors that are relevant to achieving the goal. What are all the factors that will affect achieving the highest average grade? In this case the factors are the courses we take because these are the only activities from which we can gain points. If playing in the university soccer team would earn you points, then soccer should have been another factor.

Factors:

1. Mathematics.
2. Economics.
3. Accounting.
4. Communication.
5. Geography.

c. Weight (In Grade-Point Average - GPA)

Determine the influence of each factor on the total average. Each course has a different influence on the total grade-point average. Here, mathematics is the most valuable because we study Mathematics 6 hours per week; thus the total points we can gain from Mathematics is 6*100=600. On the other hand, geography is the least valuable subject because we only study geography 1 hour per week; the total points we can gain from Geography is 1*100=100.

1.	Mathematics	(6*100) 600 points
2.	Economics	(5*100) 500 points
3.	Accounting	(4*100) 400 points
4.	Communication	(3*100) 300 points
5.	Geography	(1*100) 100 points

The total numbers of points available this quarter is 1900.

d. Percent

In this case, percent is the weight of the test grade to the total grade in each course. Each test has a different effect on the total grade for the specific course: the test in mathematics is 50% of the math grade; the test in geography is only 5% of the geography grade.

1.	Mathematics	(test #3)	50%=0.5
2.	Economics	no test	0%=0
3.	Accounting	no test	0%=0
4.	Communication	(test #2)	25%=0.25
5.	Geography	(test #1)	5%=0.05

e. Unit

Unit is defined in terms of time, a block of hours dedicated to studying a specific subject. In this example we have only 20 hours for studying for

these tests. We don't want to study 30 minutes for one test and switch to another subject because 30 minutes will not be useful as a studying period and will not provide enough time to enter the material, to understand it and to improve. We have to determine the minimal unit of time we can usefully invest understanding. In this example, let's assume that one unit will be 4 hours. We have a total of 20 hours, so we have 5 units of study time (20/4).

Unit: 4 hours

Number of units: 5 units (of 4 hours each)

f. Improvement

The student has to estimate the growth in knowledge and grade by investing the next unit of time in each subject. The improvement factor is our ability to raise our grade in each test by investing one unit of time (4 hours) in that subject. For example, if we are mathematics experts and can solve every question in this area without any additional preparation, we cannot improve our grade in mathematics; we already will get 100% on the test. Thus our ability to improve is 0%. However, if this is not the situation, and we think that by spending one unit of time (4 hours) in studying mathematics we can increase our score in the test by 20 percent, our improvement for the next unit of time is 20% (0.2).

1.	Mathematics	(test #3)	20%=0.2
2.	Economics	no test	0%=0
3.	Accounting	no test	0%=0
4.	Communication	(test #2)	15%=0.15
5.	Geography	(test #1)	10%=0.1

g. Calculations

We have to calculate two things: the real weight of each test - the value of test in points - relative to the overall grade, and the real value of time - our benefit (in points) by spending one unit of time in each test.

h. Real Weight

For each test the real weight is given by: WEIGHT * PERCENT. For example, if the total number of points we can gain from mathematics this quarter is 600 points, and if this test will be 50% of the grade this quarter, then the real weight of this math test is 600*0.5=300 points. This is the maximum points that can be gained from the math test. A similar calculation estimates the maximum points that can be earned in each subject this week.

REAL-WEIGHT = WEIGHT * PERCENT

1.	Mathematics	(test #3)	600*0.5=300
2.	Economics	no test	500*0=0
3.	Accounting	no test	400*0=0
4.	Communication	(test #2)	300*0.25=75
5.	Geography	(test #1)	100*0.05=5

i. Real-Value of Time

The real value of time is the benefit from investing one unit of time in each factor. For example, if the real-weight of the test in mathematics is 300 points, and we think that by spending 4 hours (one unit of time) in studying math we will improve our score in this test by 20%, then the real value of this unit of time is 300*0.2=60 points. This is the guide for the best investment of time. This is the number of points that can be gained by investing one unit of time preparing for each test. The real value of time is:

REAL-VALUE OF TIME = REAL-WEIGHT * IMPROVEMENT

1. Mathematics (test #3) 300*0.2=60
2. Economics no test
3. Accounting no test
4. Communication (test #2) 75*0.15=11.25
5. Geography (test #1) 5*0.1=0.5

j. Table

To clarify the process it is recommended to create a table. Arrange the details in the table to summarize the above information. An example of such a table is given here (Table 5).

Table 5. Investment of the First Unit of Time for Tests

Example Table (Numbers from Example #2 in Points)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
MATHEMATICS	600	0.5	300	0.2	**60**	*
ECONOMICS	500	NO TEST			0	
ACCOUNTING	400	NO TEST			0	
COMMUNICATION	300	0.25	75	0.15	11.25	
GEOGRAPHY	100	0.05	5	0.1	0.5	
TOTAL	1900		380			

In this example invest the first unit of time in math

The meaning:
The total number of points available this quarter for the GPA: 1900.
The total number of points to be gained by these three tests: 380.

Investing the first unit of time (4 hours) in Math will gain us 60 points.
Investing the first unit of time (4 hours) in Accounting will gain us 11.25 points.
Investing the first unit of time (4 hours) in Geography will gain us 0.5 points.

The best choice is to invest the first unit (4 hours) of time in Math.

k. Decisions

(1) **Decision Process.** We can see from Table 5 that spending the first 4 hours studying mathematics (the first unit of time) will give us

a 60 a point benefit; spending the first 4 hours studying accounting will give us a 11.25 point benefit; spending the first 4 hours studying geography will give us a 0.5 point benefit.

It is clear that the best way to spend the first 4 hours is in math; we will get more points from this subject than any others – i.e., the maximum benefit. The first unit of time should be spent preparing for the test with the highest "real value of time" (in points). By investing the first unit the student gets the maximum benefit-the maximum points.

(2) **Continue the Process.** The purpose of continuing the process is to help make the decision for the next time investment. After spending the first unit of time (the first 4 hours) in mathematics, our ability in mathematics increased and our test score will increase. Now we have to estimate our ability to improve our score in the mathematics test if we spend the next 4 hours studying math. If we estimated that we will increase our score in math by 20% when we spend the first 4 hours studying math, now, after we know more, our ability to improve by spending the next 4 hours in studying math will be equal to or less than 20%. In this example, I assume that spending the next 4 hours in math will increase our test score by 15%. It is important to understand that our score in all other courses will not change; we did not spend time studying for these tests. An example of spending the next unit of time (the next 4 hours) is given here (in Table 6):

Table 6. Investment of the Next Unit of Time for Tests

The only thing we have to change is the ability to improve in Math (from 0.2 to 0.15)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME
MATHEMATICS	600	0.5	300	**0.15**	**45**	*
ECONOMICS	500	0	0		0	
ACCOUNTING	400	0	0		0	
COMMUNICATION	300	0.25	75	0.15	11.25	
GEOGRAPHY	100	0.05	5	0.1	0.5	

The highest benefit will be by investing the next unit of time (4 hours) in Mathematics - gaining 45 points.

We can see from Table 6 that spending the next 4 hours studying mathematics (the second unit of time) will give us a 45-point benefit. Spending the next 4 hours studying (the second unit of time) accounting will give us an 11.25-point benefit. Spending the next 4 hours studying geography will give us a 0.5-point benefit.

It is clear that the second 4 hours should still be spent in math; we will get the maximum points from math – the maximum benefits (45 points).

Each unit of time should be spent preparing for the test with the highest marginal "real value of time" (in points). By investing in this way, you get the maximum benefits-the maximum points. The process should be done again after each unit of time to decide where to invest the next unit. This should be done by estimating the new "improvement" and by reevaluating the worth of each unit. After studying one subject for a unit (of time), the "improvement" in that subject has changed and now is equal to or smaller than before. Therefore after every 4 hours (one-unit), you have to change the "improvement" to a new value. Find the factor with the new highest "real value of time" and invest there.

(3) **Optional Alternative Schedule.** The process can be done in advance. In order to arrange an accurate studying schedule, these calculations can be made ahead. If you choose to study this way, you have to estimate all the changes in "improvement" at the beginning of the process and not sequentially after each unit of time then calculate best use of time in the same way. This procedure will give you a full picture of how many units need to be spent in each subject; therefore, the order of the studying will be flexible but study time will be allocated in exactly the same proportion.

(4) **Process Tables.** The example of spending 5 units of time (20 hours which are 5 units of 4 hours each) is given here (Table 7.1 - 7.5).

Tables 7.1 - 7.5. Investment of Five Units of Time for Tests (Five Units of Four Hours Each)

Table 7.1

STEP 1 investing the first unit of time

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	0.2	**60**	*	
ECONOMICS	500	0	0		0		NO TEST
ACCOUNTING	400	0	0		0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be by investing the next unit of time (4 hours) in mathematics - gaining 60 points

INVEST IN MATH

Table 7.2

STEP 2 investing the second unit of time

The only thing we have to change is the ability to improve in Math (from 0.2 to 0.15)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	**0.15**	**45**	*	
ECONOMICS	500	0	0		0		NO TEST
ACCOUNTING	400	0	0		0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be by investing the next unit of time (4 hours) in mathematics - gaining 45 points

INVEST IN MATH

Table 7.3

STEP 3 investing the third unit of time

The only thing we have to change is the ability to improve in Math (from 0.15 to 0.05)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	**0.05**	**15**	*	
ECONOMICS	500	0	0		0		NO TEST
ACCOUNTING	400	0	0		0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be by investing the next unit of time (4 hours) in mathematics - gaining 15 points

INVEST IN MATH

Table 7.4

STEP 4 investing the fourth unit of time

The only thing we have to change is the ability to improve in Math (from 0.05 to 0.03)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	**0.03**	9		
ECONOMICS	500	0	0		0		NO TEST
ACCOUNTING	400	0	0		0		NO TEST
COMMUNICATION	300	0.25	75	0.15	**11.25**	*	
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be by investing the next unit of time (4 hours) in COMMUNICATION - gaining 11.25 points

INVEST IN COMMUNICATION

Table 7.5

STEP 5 investing the fifth unit of time

The only thing we have to change is the ability to improve in Communication (from 0.15 to 0.1)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	0.03	**9**	*	
ECONOMICS	500	0	0		0		NO TEST
ACCOUNTING	400	0	0		0		NO TEST
COMMUNICATION	300	0.25	75	**0.1**	7.5		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be by investing the next unit of time (4 hours) in mathematics - gaining 9 points

INVEST IN MATH

We demonstrated where to invest time (in the most valuable factor each time). The gain for the first unit of time (4 hours) is 60 points and the gain for the fifth unit of time (4 hours) is 9 points. No time was spent preparing for geography. Doing it in this order, stopping at any time will lead to the best way of time investment.

(5) **Comments**

- If you invest your time by using this proposed methodology, you will likely gain more points than in the common methodology.
- This is a general example and we must consider other relevant constraints such as:
  - You must pass all the tests.
  - You want at least x hours before a test to refresh your knowledge.
- It is important to understand that the ability to improve stays equal, or decreases or increases after spending some time in a subject. For example, if the ability to improve the score by studying math for the first 4 hours is 20%, the ability to improve by studying 4 more hours of math will be equal to, less than or more than 20% depends on the situation.

- We are dealing with a learning behavior, so the most important time to use this methodology is when:
  - You have no "smart people" in the area to learn from....
  - The weight of a factor changes (i.e., if we study only 2 hours per week instead of 6, or if the math test will be 25% the total course grade instead of 50%).
  - You add or delete another factor (such as a test the same week in another subject)

(6) **Changing Situations Tables.** For illustration, Table 8 shows:

- Changing weight of test.
- Changing percent of test.
- Adding another factor.

Table 8. Point Weight Variations Related to Changing Factors

Changing Weight From 6 Hours In Math Per Week To 2 Hours Per Week

The meaning (the weights are in direct points)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	**200**	0.5	100	0.2	**20**	*	
ECONOMICS	500	0			0		NO TEST
ACCOUNTING	400	0			0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be achieved by investing the next unit of time (4 hours) in mathematics - 20 points

INVEST TIME IN MATH

Table 8 (Continued)

Changing the Percent Of Math Test from 50% To 25%

The meaning (the weights are in direct points)

(It means that the grade of this test will be only 25% from the total grade in this course and not 50%)

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	**0.25**	150	0.2	**30**	*	
ECONOMICS	500	0			0		NO TEST
ACCOUNTING	400	0			0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		

The highest benefit will be achieved by investing the next unit of time (4 hours) in mathematics - 30 points

INVEST TIME IN MATH

Adding One More Factor and a Test in This Subject

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF TIME	HIGHEST VALUE OF TIME	
MATHEMATICS	600	0.5	300	0.2	**60**	*	
ECONOMICS	500	0			0		NO TEST
ACCOUNTING	400	0			0		NO TEST
COMMUNICATION	300	0.25	75	0.15	11.25		
GEOGRAPHY	100	0.05	5	0.1	0.5		
ALGEBRA	**400**	**0.3**	**120**	**0.1**	**12**		
TOTAL	2300		500				

The highest benefit will be achieved by investing the next unit of time (4 hours) in mathematics - 60 points

INVEST TIME IN MATH

4. Discussion

People are different. They have different cultures, values, personalities, and tendencies. These differences may lead people to different goals and constraints. For example, the goal of a student in studying can be to earn the highest possible GPA. Personal or cultural reasons can create constraints such as a demand for success in each and every test in the university because of family/society tradition, prestige or respect (even though a particular test may be worth only a very low number of points to the GPA). Some students can say that pure study is the most

important factor in their values and that they do not care about the GPA. Others say that the most important purpose of studying is to learn the subject that will provide the most benefits for a future job and that grades or the weight of a subject in the university have nothing to do with how much studying is to be done. Others can say that the only thing they want to do is to pass and, thereby, only reach the minimum requirements of the university for the degree. Another student may say that studying geography is the most enjoyable thing he is doing in the university, so studying geography gives him much more than points for the GPA.

These arguments are very important and cannot be ignored. The advantage of the proposed concept is that you can better understand not only the value of measurable factors but also the value of your immeasurable factors such as enjoyment or relevancy when compared to what is most valued by students in the university - the GPA. With this knowledge you can better understand the value of immeasurable factors. When you realize the real value of time in terms of points for GPA you may face different situations, for example, sometimes you can see that the expected benefits are so low that it is much better not to study at all and to do something enjoyable instead, or that the expected benefits are so high that you had better study.... In summary, the marginal concept can help you to make more informed decisions about maximization and can give you a tool to adjust your decisions to include intangible factors.

5. Practical Behavior

- Define the goal (the highest academic grade-point average GPA).
- Understand the real weight of each test, i.e., the maximum points of GPA you can get (usually the first unit should be invested in this factor).
- Try to think about your knowledge in each area and your ability to improve in each area.

- Use your intuition to chose the most valuable area where you gain the maximum points by investing a unit of time (beginning direction).
- After a period of time, stop and think again about the new situation and decide on the next investment of time.
- **You must constantly think in terms of how many points you will gain from investing one more unit of time in each factor and choose the most valuable factor that will enable you to gain the most.**

6. Common Problems

- Unclear definition of the real goal.
- Misunderstanding of the real weight of each test, the maximum GPA points for GPA associated with each test (and the relative value among a number of tests).
- Tendency to think mainly chronologically.
- Using intuition without the necessary knowledge can lead people to make the wrong decisions about the direction and when to switch activities.

7. Mathematical Analysis

The following mathematical analysis is based on the background of this thesis.

a. Objective Function

The mission (goal) is to maximize an objective function in order to get the maximum benefits (here, test points). The objective function is a function of the time allocated to factors 1 through n (if we have n tests),

$$\theta=\theta(T1, T2, T3 \ldots Tn)$$

b. Constraint

There is a limited amount of time available for studying:

$$T1+T2+T3+\ldots. +Tn = T$$

The constraint function is

$$\phi=T1+T2+T3+\ldots+Tn-T=0$$

c. The Lagrangian Function

The Lagrangian function is:

$$L=\theta(T1, T2, T3, Tn)-\lambda(T1+T2+T3+\ldots+Tn-T)$$

d. Maximization

For maximization, the partial derivatives of this function must be equal to zero, meaning.

$$\partial L/\partial Ti=\partial\theta/\partial Ti-\lambda*1=0 \qquad \text{for every I = 1, 2, 3...n}$$

The objective function is maximized when:

$$\partial\theta/\partial T1=\partial\theta/\partial T2=\partial\theta/\partial T3=\ldots=\partial\theta/\partial Tn=\lambda$$

$$\text{and } T1 + T2 + t3 +...Tn = T$$

and

$$\theta(T1, T2,...Tn) \text{ is strictly quasi-concave}$$

A maximum is achieved when time is spent so that the marginal benefit from additional time allocated to a factor is the same for all the factors. In this example, the marginal benefit of spending an additional one unit of time (4 hours) to study for specific test is the points gained on that test for the GPA.

IV. EXPLORATION

A. INTRODUCTION

How to make the right decision is a very important issue here and a vivid expression of common behavior:

> When you are faced with a decision to make, how do you typically proceed? For most people in most circumstances, you simply decide at the particular moment based on prior experience, intuition, advice from others, etc. However, some people have a very hard time making even the most mundane decisions (spoken from experience) and, in major decisions, we all have trouble. Furthermore, even if we know with certainty what we would like to decide, we still must convince others (e.g., spouses, boss) that we know what we are doing. In this case intuition rarely suffices; the answer "because I just want to" never worked as a teenager when we confronted our parents and surely won't work with our boss. Thus, for most decisions, we either approach the problem from a holistic point of view in which we simply choose the best, or we somehow break the decision down into components in order to (a) better understand the problem we are faced with and/or (b) communicate with someone else why a particular course of action was chosen. [Ref. 4:p. 3]

B. DECISION-MAKING PROCESS

Decision making is a process (if we want to do a good job…):

> [d]ecisions which are truly important cannot be made in a single meeting....People need time to think about a decision, gather new information, negotiate....Thus, any real decision problem involves a process of learning, debating, and revising one's priorities." [Ref. 4:p. 13]

There are four major parts in the process:

- Identify yourself as the expert.
- Create the ability to see the whole picture
- Create the tools to calculate and understand the value of the benefits

- Calculate and make the decision process.

In this chapter I will write about these four major parts of the process and about our tendencies in these areas as human being.

1. Identifying Yourself as the Expert

The decision-maker and the expert here are the same person. You have to adopt the idea that you are the expert in deciding the best way to deal with issues.

2. Creating the Ability to See the Whole Picture

You are standing in front of an important part of the solution which forces you to take a broad view: The ability to see the **whole picture** and to define your goals, the factors, and the constraints. It means the following:

Goals - you must (truly) determine your personal objective, like money /points/ prestige/... you want to achieve (in economics language, this is the objective function you want to maximize/ minimize).

Factors - you have to define the main actions that can affect the goal.

Mansfield wrote:

> The conduct of...enterprise requires a successive series of.... decisions - decisions between possible alternatives with reference to the future. These decisions are of all degrees of importance, varying from trivial matters to matters of major policy. Some of them are made by intuitive judgments or "hunches" without any conscious attempt to express the alternatives to be compared in commensurable terms, or perhaps even to see clearly what these alternatives really are. Others, however, involve choices between definite alternatives which have been made commensurable by reducing them to terms of money and time. [Ref. 6:p. 11]

(In economics language these are the factors in which you should invest your limited resources).

Constraints- you have to determine the limitations and pre-conditions you have (in economics language these are the constraints)

3. Creating the Tools to Calculate and Understand the Value of the Benefits

After defining the goals, factors and constraints, you have forced yourself to consider the whole picture; you are on the right track.

Unit - you have to think in terms of how to use slices of your limited resources (like time, money etc.), and for this you should define the minimal unit of resource you want to invest in one action to be effective in improving your outcome so you do not just jump ineffectively from one subject to another

Weight - you have to estimate the influence of each factor by estimating or understanding each factor in terms of the goal (money, points….).

Percent - you have to estimate how much you can gain from this factor if you have all the time needed for this mission

Improve - you have to estimate the effect of investing one unit of time in each factor (percent) in terms of the goal (how much you will be able to improve your ability in this factor per one unit of time).

4. Decision

a. Calculation

After seeing the whole picture and estimating your resources, you have to calculate where the best place is to invest your time. You can do it by creating a "table" to better understand the picture.

Real weight - you have to calculate the maximum benefits, in terms of the goal (like money points etc.), you can get from each action.

Real value of time - you have to calculate the benefits in terms of the goal (like money, points, etc.) you can gain or save by spending/investing the next unit of time in each factor.

b. Understanding the Benefits

We are looking for the factor in which by investing one unit of resources we will gain the most improvement in our goal. This is calculated by multiplying the improvement by the real-weight of each factor and then choosing the highest benefits. When you finish using a unit, repeat the process. The only thing that changes is the value of improvement in the factor in which you just used your resources. (Be aware of the fact that as your knowledge in a factor increases, the improvement decreases).

c. Making the Decision

Decision making is a process of choosing where to spend the next unit of your limited resources. In the beginning, you decide where to spend the first unit of time, then where to spend the second, then the third, etc. The main idea is to find the expected benefits we can get from each action before choosing the action with the highest expected benefits (in terms of the goal like money, points, prestige, etc.). You should invest in the factor that will give you the highest benefit. It is recommended that you create a table for calculating the best place to invest/spend time. Table 9 is an example of a generic table.

Table 9. Generic Table

FACTOR	WEIGHT	PERCENT	REAL WEIGHT	IMPROVE BY 1 UNIT	REAL VALUE OF UNIT	HIGHEST VALUE OF UNIT
f1	w1	p1	w1*p1	m1	w1*p1*m1	
f2	w2	p2	w2*p2	m2	w2*p2*m2	
f3	w3	p3	w3*p3	m3	w3*p3*m3	*
f4	w4	p4	w4*p4	m4	w4*p4*m4	
f5	w5	p5	w5*p5	m5	w5*p5*m5	

Investing the first unit of time in f1 will gain us w1*p1*m1.
Investing the first unit of time in f2 will gain us w2*p2*m2.
Investing the first unit of time in f3 will gain us w3*p3*m3.
Investing the first unit of time in f4 will gain us w4*p4*m4.
Investing the first unit of time in f5 will gain us w5*p5*m5.

The best choice is to invest the first unit where the benefit is the highest. This means choosing the factor i where wi*pi*mi is the largest (here i=3 because w3*p3*m3 is the highest).

Before investing the next unit of the limited resource, change only one thing in this table – the ability to improve in the factor in which you just invested then compare the expected benefits across actions from spending the next unit of time and pick the factor with the highest expected benefits.

C. DISCUSSION

There are differences among people. People have different backgrounds in wealth, culture, values, personality, flexibility, willingness to change, and need for harmony. These characteristics may lead different people to different goals. Goals are not always clear cut and cannot always be measured as money or points. Sometimes the goal is a combination of the measurable and the immeasurable (such as enjoyment, happiness, harmony or prestige).

The immeasurable factors are an important part of decision making and cannot be ignored. The advantage of the proposed concept is that it provides the necessary knowledge to make decisions. The concept helps to understand the cost and the benefits by investing in each factor, and it allows people to better understand the cost of immeasurable factors and to decide how to adjust their decisions to include them.

D. TENDENCY OF PEOPLE

People tend to skip the first and most important part of decision making - defining their goals, factors and constraints. People tend to deal with areas with which they are familiar, skip new areas, and choose subjects based on chronology or commercial desires, and not based on the real value of the subject. Inside the chosen factor most people know to maximize, but, when dealing with just one

factor, it is difficult for them to step outside see the whole picture and switch factors. People also tend to follow the behavior of "smart people." This works when you have smart people to follow; when you handle a new subject or change information, this approach can create problems.

We used to think that the intuition of people leads toward logical behavior. Unfortunately, it does not necessarily work that way because of lack of knowledge, as Golden Wasil and Harker write : "The final result may not agree with my 'gut feeling'" [Ref. 4:p. 13].

We can see that it is difficult for people to determine the first direction to take and when to switch their emphasis. Many people do not try to improve their way of thinking because they often need to compare tangible results to another way of thinking, unfortunately, they do not always have such a comparison available.

E. SUMMARY

In summary you must remember that:

- You are the expert and no one else can determine your goal, factors or constraints.
- If you determine the goal, factors and constraints by following this process, you will be forced to get a clearer view of the picture.
- You should create the tools that will help you understand the value of each factor.
- You have to calculate the marginal benefit toward your goal by investing one unit in each factor
- You should choose to invest in the factor that gives you the maximum benefit.
- The two main things in the process are taking the right direction and switching between factors at the correct moment.

In order to use the marginal idea, we must follow the first two steps in the process - identifying yourself as the expert and creating the ability and the tools

needed to see the whole picture. Only then can we use marginalism to help us make the right decisions. The marginal concept provides tools for adjustment in thinking to include the immeasurable factors in the decision-making process.

V. CONCLUSIONS

Almost every issue can be handled using the marginal concept. Adopting the economic way of thinking enables everyone to reach the best decisions. The process of decision making answers the two basic questions: 1) Where "to go," and 2) When and where to switch emphasis. The concept is based on four major steps:

- The first step is to understand and to believe that you are the expert when dealing with your own issues.
- The second step is to see the whole true picture. This should be done by defining the goal, the factors and the constraints.
- The third step is to create the tools and to estimate the impact of alternative actions. This should be done by defining the weights, the unit of resource use, the potential improvement from investing resources and the value of that improvement.
- The forth step is to calculate and understand where to invest the next unit of resources. Resources should be invested in the factor that gives the biggest benefit from the next unit of resources.

You must be aware of the following points:

- Try to define your real goal.
- The goal must be defined first (like saving the maximum amount of money) and then all the factors that can affect that goal can be found. You cannot find the factors if you do not define the goal because the factors are created according to the goal. This whole process will enable you to see the whole picture.
- Try to identify all the relevant factors to the issue. Don't skip this basic part.
- Remember that in order to make the right decisions you must see the whole picture.
- Be aware of the tendency to invest time in familiar patterns. Force yourself to think positively about investing time in unfamiliar areas.
- Be aware of the fact that you will possibly need to switch factors in which you should invest during the process.

- The chronological approach sometimes can be confusing and may lead you in the wrong direction.
- Depending only on intuition here can be dangerous.
- Even though gaining benefits from one factor, think whether you are investing your time in the right activity....
- Your time is a very important resource.
- Whenever changing the problem like adding a factor or changing the weight of factor, recalculate and act purposefully.
- Sometimes the best solution is not found "inside the box." Thinking in an "unconventional way" can help.
- Adjustments to include immeasurable factors in the process can be done by understanding the cost of these factors.
- This concept allows you to act logically with relevant and important knowledge to make the right decisions.
- Don't forget the four major steps:
  - You-understand and believe that you are the expert.
  - Whole picture-take the actions necessary to see the whole picture.
  - Tools-create the tools for calculating and understanding the benefits
  - Calculations and Decision-calculate where is the highest benefit for investing one unit. Decide where to invest and when to switch your investment.

If you do not act in the proposed way you will reach some goal, but it will probably not be the goal you really want to achieve.... You can reach your real goal. Hopefully this work will lead you who read it to think about what you are doing and whether you have the knowledge to make the right decisions. You cannot do everything, so you have to choose what to do and to choose wisely! Good luck.

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